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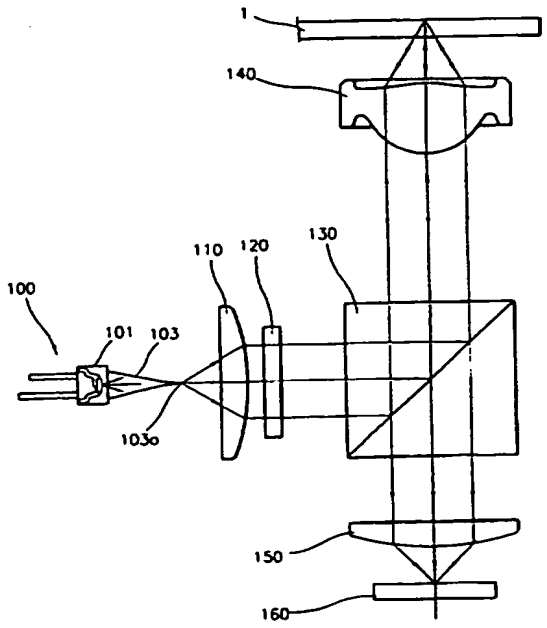
(54) Abstract Title
Optical pickup includes waveguide for condensing light from source

(57) The optical pickup includes: a light source unit 100 including a light emitting diode (LED) 101 for emitting light and a waveguide 103 for condensing the light emitted from the LED 101; a collimating lens 110 for collimating the light emitted from the waveguide 103; an objective lens 140 for condensing the light passed through the collimating lens 110 to form a light spot on the recording surface of a recording medium 1; light path changing means 130 arranged on an optical path between the collimating lens 110 and the objective lens 140, for changing a travelling path of the incident light; and a photodetector 160 for receiving the light incident via the objective lens 140 and the light path changing means 130 after being reflected from the recording medium 1.

A further embodiment (Fig 3) uses a plurality of LEDs, each having a respective waveguide.

FIG.2



GB 2 328 776 A

FIG.1 (PRIOR ART)

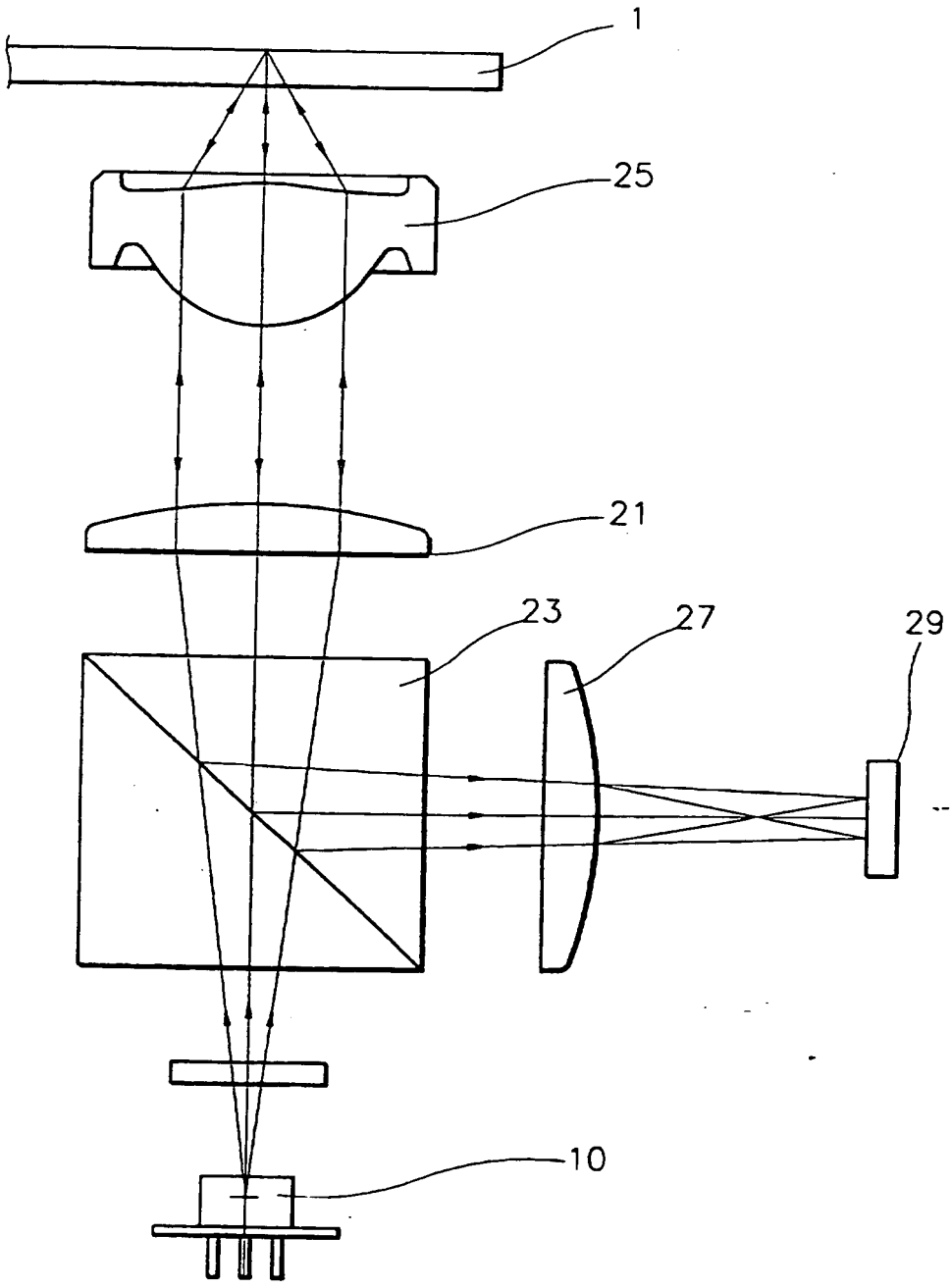


FIG.2

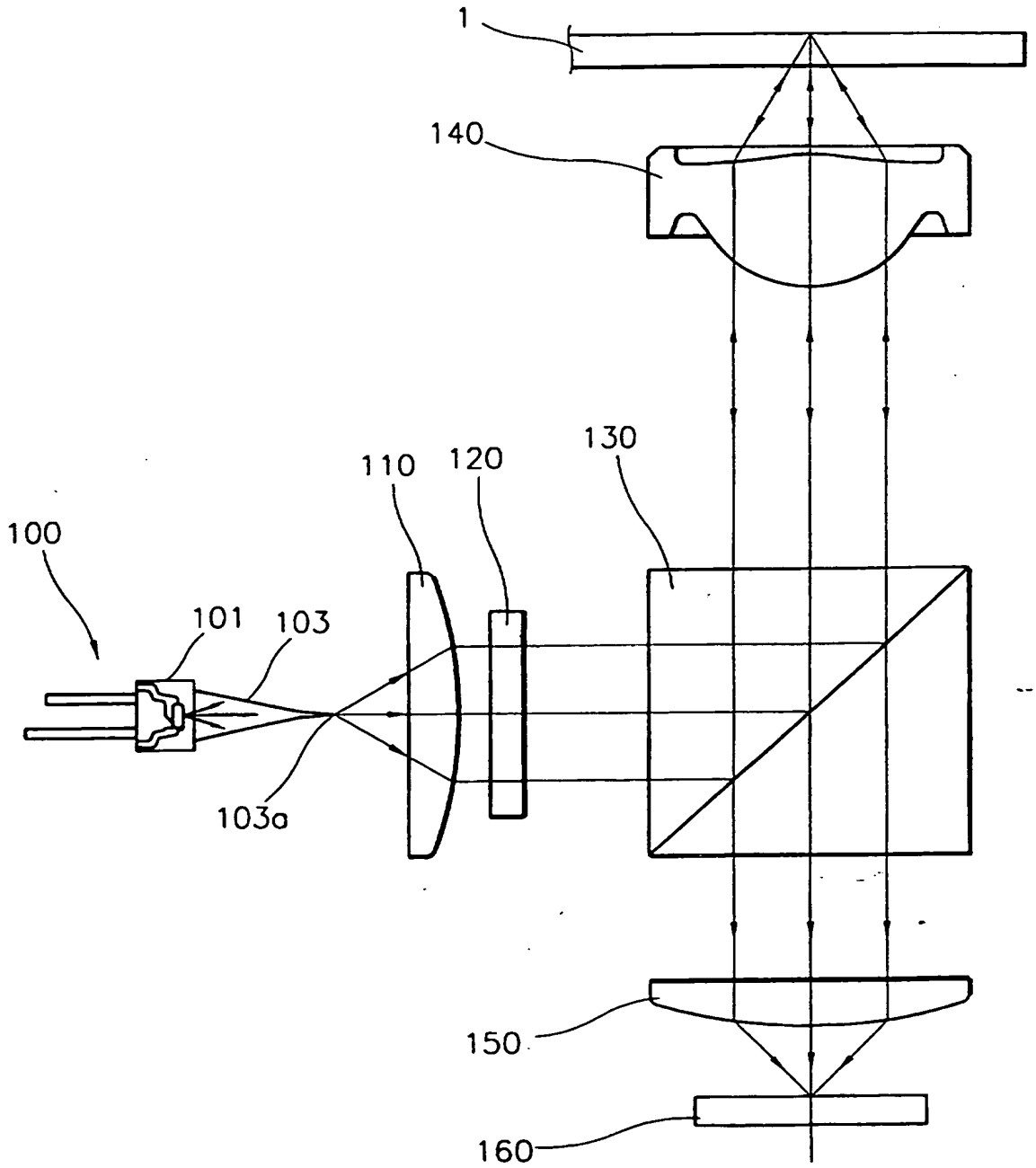
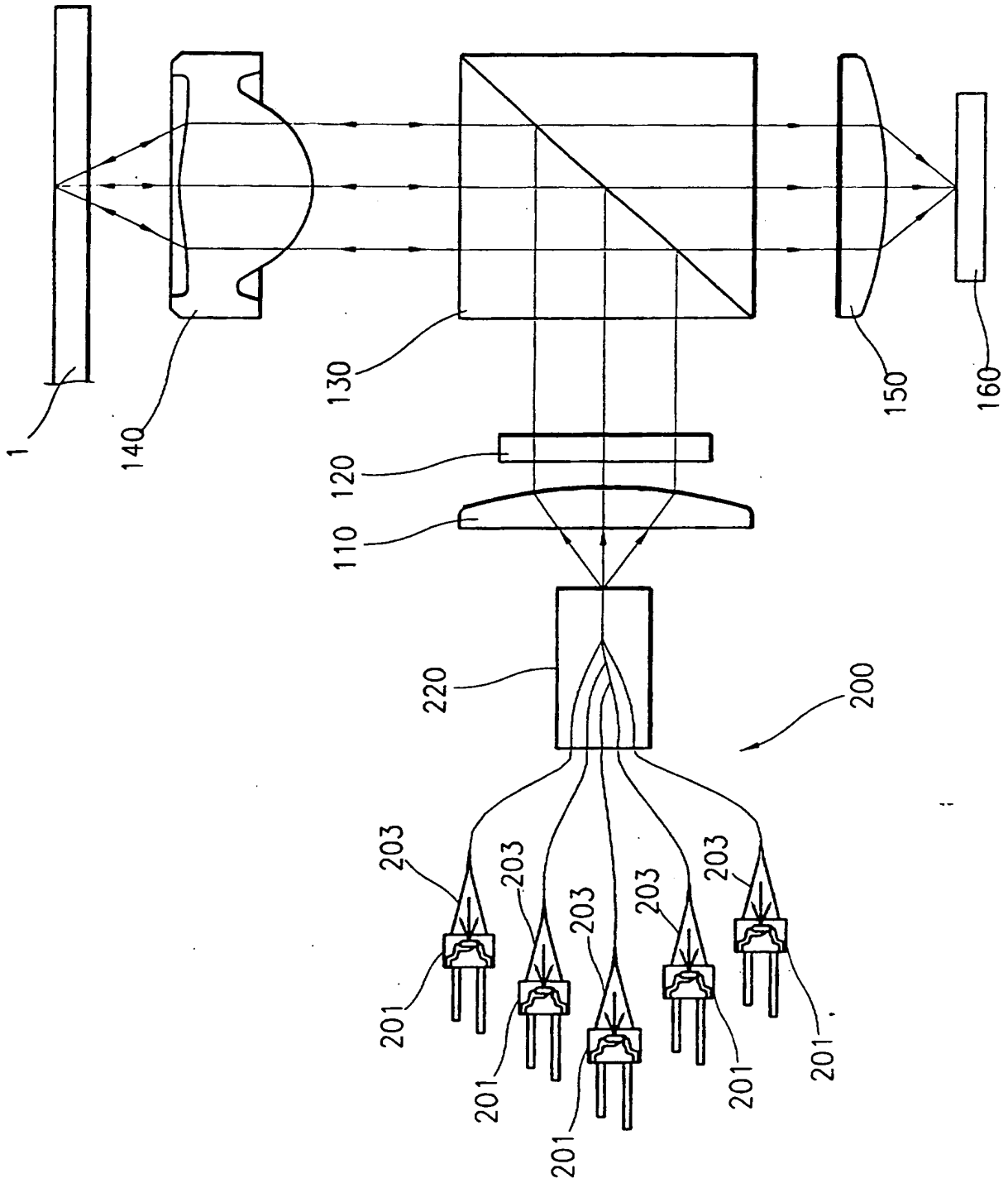


FIG.3



OPTICAL PICKUP FOR RECORDING/REPRODUCTION

The present invention relates to an optical pickup, and more particularly, to an optical pickup capable of performing a high-density recording or reproduction.

In general, an optical pickup is adopted to a disk player to record or reproduce information such as image and sound on or from a disk type recording medium. To increase the recording density on a recording medium, the size of a light spot formed on the recording medium must be made as small as possible by an objective lens of an optical pickup. To this end, the optical pickup for recording or reproducing information on or from a digital versatile disk (DVD) adopts an objective lens having a large numerical aperture and a light source of 650nm wavelength.

Referring to Figure 1, a conventional optical pickup includes a semiconductor laser 10, an objective lens 25 for converging an incident light to form a light spot on a recording medium 1, a beam splitter 23 for changing an optical path of the incident light, and a photodetector 29 for detecting the incident light and generating a radio frequency (RF) signal and an error signal. The semiconductor laser 10 is a general edge emitting laser for emitting a light of 650nm.

Also, a collimating lens 21 for collimating the divergent light emitted from the semiconductor laser 10 is placed on an optical path between the semiconductor laser 10 and the objective lens 25. Also, an astigmatism lens 27 is located between the beam splitter 23 and the photodetector 29.

The light emitted from the semiconductor laser 10 passes the beam splitter 23, and is then focused by the objective lens 25 to form a light spot on the recording surface of the recording medium 1. The light reflected from the recording surface of the recording medium 1 travels toward the photodetector 29 via the objective lens 25, the beam splitter 23 and the astigmatism lens 27, and the photodetectors 29 generate the RF signal and the error signal.

Here, the size of the light spot formed on the recording surface of the recording medium satisfies the following relationship (1).

$$\text{size of light spot} \sim \frac{\lambda}{NA} \quad \ldots(1)$$

where λ represents the wavelength of the semiconductor laser 10, and NA represents the numerical aperture of the objective lens 25. Thus, in order to achieve high-density recording/reproduction, the size of the light spot must be made small by using the semiconductor laser 10 emitting a short wavelength light, and/or the objective lens 25 having a large numerical aperture.

However, when using the objective lens 25 having a large numerical aperture, aberration caused by the tilt of the recording medium increases, thereby lowering the stability of the light spot. Also, semiconductor lasers 10 capable of emitting a short wavelength light are expensive.

Due to the above reasons, the DVD adopts an objective lens having a numerical aperture of 0.6 and a

semiconductor laser emitting 650nm wavelength light. In this case, the size of the light spot formed on the recording medium 1 becomes 1.08μm in diameter. However, it is difficult to record 5 Giga bytes of information or more on one side of a recording medium of a 120nm-diameter disk by using an optical pickup forming such a light spot size.

Thus, the optical pickup cannot be adopted to record or reproduce large quantities of information, as in the case of a high definition (HD) television which requires processing at least 10 Giga bytes of information or more.

With a view to solve or reduce the above problems, it is an aim of preferred embodiments of the present invention to provide an optical pickup capable of recording/reproducing much information at high density using a light-emitting diode (LED) whose costs are comparatively low.

According to an aspect of the above invention, there is provided an optical pickup for recording/reproduction, comprising: a light source unit including a light emitting diode (LED) for emitting light and a waveguide for condensing the light emitted from the LED; a collimating lens for collimating the light emitted from the waveguide; an objective lens for condensing the light passed through the collimating lens to form a light spot on the recording surface of a recording medium; light path changing means arranged on an optical path between the collimating lens and the objective lens, for changing a travelling path of the incident light; and a photodetector for receiving the light incident via the objective lens and the light path changing means after being reflected from the recording medium.

The waveguide preferably has a conical shape, and is installed at the LED.

The LED preferably emits the light having approximately 550nm or less wavelength.

The collimating lens is preferably a gradient-index (GRIN) lens whose refractive index changes along the radial direction of the optic axis.

The pick-up preferably comprises an optical filter installed between the LED and the light path changing means, for passing only the light of a predetermined wavelength of the light emitted from the LED.

According to another aspect of the invention, there is provided an optical pickup for recording/reproduction, comprising: a plurality of light-emitting diodes (LEDs) for emitting light; a plurality of waveguides coupled with each LED, for condensing the light emitted from the LEDs; a coupler for coupling the light emitted from the plurality of waveguides onto one optical path; an objective lens for condensing the light passed through the collimating lens to form a light spot on the recording surface of a recording medium; light path changing means arranged on the optical path between the collimating lens and the objective lens, for changing the travelling path of the incident light; and a photodetector for receiving the light incident via the objective lens and the light path changing means after being reflected from the recording medium.

Preferably, the collimating lens is a gradient-index (GRIN) lens whose refractive index changes along the radial direction of the optic axis.

Preferably, in the optical pickup the LED emits the light having approximately 550nm or less wavelength.

Also, preferably, the waveguide has a conical shape, and is installed at the LED.

Also, the optical pickup may further comprise an optical filter installed between the LED and the light path changing means, for passing only the light of a predetermined wavelength of the light emitted from the LED.

For a better understanding of the invention, and to show how embodiments of the same may be carried into effect, reference will now be made, by way of example, to the accompanying diagrammatic drawings, in which:

Figure 1 is a schematic view showing the optical arrangement of a conventional optical pickup;

Figure 2 is a schematic view showing the optical arrangement of an optical pickup for recording/ reproduction according to a preferred embodiment of the present invention; and

Figure 3 is a schematic view showing the optical arrangement of an optical pickup for recording/ reproduction according to another preferred embodiment of the present invention.

Referring to Figure 2, an optical pickup for recording/reproduction according to a preferred embodiment of the present invention includes a light source unit 100 for emitting light, a collimating lens 110 for collimating the light emitted from the light source unit 100, a light

path changing means 130 for changing a travelling path of the incident light, an objective lens 140 for converging the incident light, and a photodetector 160 for receiving the incident light. Here, a condensing lens 150 can be further comprised between the light path changing means 130 and the photodetector 160, which is for condensing the parallel light being incident via the light path changing means 130 to form a light spot on the photodetector 160.

The light source unit 100 includes a light-emitting diode (LED) 101 for emitting light and a waveguide 103 for converging and transmitting the light emitted from the LED 101.

The LED 101 emits a light whose wavelength is 650nm or less, preferably, approximately 550nm or less, such that the size of the light spot formed on the recording surface of a recording medium 1 can be optimized.

The waveguide 103 is installed at the output end of the LED 101. To increase the efficiency in converging the light, the waveguide 103 may have a conic shape. That is, the diameter of the waveguide 103 gradually decreases farther away from an output end of the LED 101. Preferably, the diameter of an output end 103a of the waveguide 103 is 10μm or less. Also, the output end 103a may have a predetermined length to transmit the condensed light. Here, the conic wall of the waveguide 103 condenses the light by completely reflecting the light emitted from the LED 101.

On the other hand, the waveguide 103 may be an optical fiber with a conical core, and the diameter of the core at the output end 103a may be 10μm or less.

The collimating lens 110 is arranged between the LED 101 and the light path changing means 130, that is, at the output end 103a of the waveguide 103, and collimates the light condensed by the waveguide 103. Here, preferably, the collimating lens 110 is a gradient-index (GRIN) lens whose refractive index gradually decreases moving away from the optic axis in the radial direction, so that the GRIN lens has excellent condensing efficiency.

The optical filter 120 installed on the optical path between the LED 101 and the objective lens 140 passes only a predetermined wavelength of the light emitted from the LED 101. That is, only the light having a narrow bandwidth of the light emitted from the LED 101 is incident on the recording medium 1 via the optical filter 120. Here, preferably, the optical fiber 120 has a bandwidth within ±10nm with respect to the central transmission wavelength, that is, a bandwidth within 20nm. In this case, the light passed through the optical filter 120 has a bandwidth within ±10nm of the central wavelength, that is, the bandwidth within 20nm. According to embodiments of the present invention, even if a low-priced LED 101 is adopted as a light source, a light having a narrow bandwidth can be emitted to provide the same effect as a high-priced semiconductor laser.

The light path changing means 130 reflects most of the light incident from the LED 101 toward the recording medium 1 and transmits the light reflected from the recording medium 1 toward the photodetector 160. The light path changing means 130 may be a beam splitter for transmitting or reflecting the incident light with a predetermined ratio, or a polarizing beam splitter for transmitting or reflecting the incident light according to a polarization state.

The objective lens 140 is placed on the optical path between the light path changing means 130 and the recording medium 1, and condenses the incident light to form a light spot on the recording surface of the recording medium 1. Preferably, the condensing lens 150 is an astigmatism lens capable of detecting a focusing error signal by an astigmatism method.

The photodetector 160 receives the light reflected from the recording surface of the recording medium 1 to generate an RF signal and an error signal.

In the operation of the optical pickup, if the light emitted from the light source unit 100 has a wavelength of 400nm, the size of the light spot formed on the recording surface of the recording medium 1 is about 0.67μm by the equation (1). This size is approximately 0.62 times smaller than that formed by the conventional optical pickup. Thus, the recording density is increased by approximately 2.6 times compared to that of the conventional pickup. For example, approximately 13 Giga bytes information or more can be recorded on a 120mm diameter disk.

An optical pickup for recording/reproduction according to another embodiment of the present invention is shown in Figure 3. Here, the same reference numerals as those of the previous drawings represent the same elements.

A light source unit 200 includes a plurality of LEDs 201 for emitting light, a plurality of waveguides 203 arranged at respective output ends of the LEDs 201, and a coupler 220 for coupling the light passed through the plurality of waveguides 203 into one light.

The LEDs 201 may be selectively driven by a switching means (not shown). The coupler 220 sequentially couples the light emitted from the output ends of each waveguide 203 onto one optical path.

In the operation of the optical pickup according to this embodiment of the present invention, since the plural LEDs 201 operate selectively, the intensity of the light spot can be controlled whether for recording information which requires light of a comparatively high intensity or for reproducing information which requires comparatively less light intensity, respectively.

As described above, optical pickups of embodiments of the present invention adopt lower-priced LEDs, so that the manufacturing costs are low. Also, the optical pickup includes a conical waveguide for condensing the light emitted from the LED, thereby improving condensing efficiency.

In addition, by adopting a plurality of LEDs which operate selectively, a light spot of a desired intensity can be formed.

The reader's attention is directed to all papers and documents which are filed concurrently with or previous to this specification in connection with this application and which are open to public inspection with this specification, and the contents of all such papers and documents are incorporated herein by reference.

All of the features disclosed in this specification (including any accompanying claims, abstract and drawings), and/or all of the steps of any method or process so disclosed, may be combined in any combination,

except combinations where at least some of such features and/or steps are mutually exclusive.

Each feature disclosed in this specification (including any accompanying claims, abstract and drawings), may be replaced by alternative features serving the same, equivalent or similar purpose, unless expressly stated otherwise. Thus, unless expressly stated otherwise, each feature disclosed is one example only of a generic series of equivalent or similar features.

The invention is not restricted to the details of the foregoing embodiment(s). The invention extends to any novel one, or any novel combination, of the features disclosed in this specification (including any accompanying claims, abstract and drawings), or to any novel one, or any novel combination, of the steps of any method or process so disclosed.

CLAIMS

1. An optical pickup for recording/reproduction, comprising:

a light source unit including a light emitting diode (LED) for emitting light and a waveguide for condensing the light emitted from the LED;

a collimating lens for collimating the light emitted from the waveguide;

an objective lens for condensing the light passed through the collimating lens to form a light spot on the recording surface of a recording medium;

light path changing means arranged on an optical path between the collimating lens and the objective lens, for changing a travelling path of the incident light; and

a photodetector for receiving the light incident via the objective lens and the light path changing means after being reflected from the recording medium.

2. The optical pickup of claim 1, wherein the waveguide has a conical shape, and is installed at the LED.

3. The optical pickup of claim 1 or 2, wherein the LED emits the light having approximately 550nm or less wavelength.

4. The optical pickup of claim 1, 2 or 3, wherein the collimating lens is a gradient-index (GRIN) lens whose refractive index changes along the radial direction of the optic axis.

5. The optical pickup of claim 1, 2, 3 or 4, further comprising an optical filter installed between the LED and the light path changing means, for passing only the light of a predetermined wavelength of the light emitted from the LED.

6. An optical pickup for recording/reproduction, comprising:

a plurality of light-emitting diodes (LEDs) for emitting light;

a plurality of waveguides coupled with each LED, for condensing the light emitted from the LEDs;

a coupler for coupling the light emitted from the plurality of waveguides onto one optical path;

an objective lens for condensing the light passed through the collimating lens to form a light spot on the recording surface of a recording medium;

light path changing means arranged on the optical path between the collimating lens and the objective lens, for changing the travelling path of the incident light; and

a photodetector for receiving the light incident via the objective lens and the light path changing means after being reflected from the recording medium.

7. The optical pickup of claim 6, wherein the waveguide has a conical shape, and is installed at the LED.

8. The optical pickup of claim 6 or 7, wherein the LED emits the light having approximately 550nm or less wavelength.

9. The optical pickup of claim 6, 7 or 8, wherein the collimating lens is a gradient-index (GRIN) lens whose refractive index changes along the radial direction of the optic axis.

10. The optical pickup of claim 6, 7, 8 or 9, further comprising an optical filter installed between the LED and the light path changing means, for passing only the light of a predetermined wavelength of the light emitted from the LED.

11. An optical pickup substantially as herein described with reference to Figure 2.

12. An optical pickup substantially as herein described with reference to Figure 3.

The Patent Office

14

Application No:	GB 9810817.8	**Examiner:**	Peter Easterfield
Claims searched:	1 to 10	**Date of search:**	6 October 1998

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.P): G5R (RLE)

Int Cl (Ed.6): G11B 7/12, 7/125, 7/135

Other:

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
A	EP 0648049 A1	(HITACHI) see fig 11	1
A	EP 0483438 A1	(IBM) see 37.1, 37.2 in fig 4	1
A	US 5195152 A	(GUPTA) see 92, fig 9	1, 6
A	US 4815067 A	(WEBSTER et al) see 10, fig 1	1, 6

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.